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ABSTRACT

As a result of declining scores, the National Science Foundation has funded numerous materials-development grants. Largest among these is the Interactive Media Science (IMS) Project at Florida State University (FSU) in Tallahassee. This project's mandate is to design, develop, and produce six level III interactive videodisc programs for middle school science instruction. These innovative programs will provide students with numerous opportunities to become involved in activities that would be impossible for them in the normal classroom setting. Using the ScienceVision program, students are able to conduct experiments, visit locations, listen to experts, make decisions, collect data, and solve the problems posed on the videodisc. Factors influencing the design and development of the six discs are: (1) prior research into instructional videodisc technology; (2) characteristics of the target audience; (3) capabilities of the medium; (4) the inquiry-based learning philosophy advocated by the project; and (5) the state of technology in the schools. Developed by experienced teachers, the program was also designed to address the limits of the classroom. The fundamental assumption of ScienceVision is that science education should be multidisciplinary and should provide a general science background for all students. The goals of ScienceVision are twofold: to provide students with a valid understanding of science as a human enterprise and to present science as a search for knowledge based upon interpretation of data. The content, context, cognition, inquiry-based learning, reasons why level III interactive videodiscs should be used, classroom structure, hardware requirements, research with ScienceVision, and educational implications of ScienceVision are topics of discussion. A list of contact persons is included. An overview and status of the project's products are appended. EcoVision, ErgoMotion, AstroVision, Chemical Pursuits, Life Skills, TerraVision, and Water and Weather are the programs that are described. (KR)

ScienceVision

An Inquiry-Based Videodisc Science Curriculum

George Dawson

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ScienceVision
An Inquiry-Based Videodisc Science Curriculum
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As a result of declining scores, the National Science Foundation has funded numerous materials-development grants in the past three years. Largest among these is the Interactive Media Science (IMS) Project at Florida State University (FSU) in Tallahassee.

The IMS Project is a joint effort of several different organizations. It is being developed and produced by the FSU College of Education's Science Education Program and the Center for Instructional Development and Services. The finished courseware materials (ScienceVision) will be marketed by Houghton Mifflin Company, which is publishing an interrelated, but independent textbook series. Apple Computer and Pioneer Electronics have contributed hardware and technical support.

Background

This project's mandate is to design, develop, and produce six level III, interactive videodisc programs for middle-school-science instruction. These innovative programs will provide students with numerous opportunities to become involved in activities that would be impossible for them in the normal classroom setting. Using the ScienceVision program, students are able to conduct experiments, visit locations, listen to experts, make decisions, collect data, and solve the problems posed on the videodisc.

Each disc will contain approximately fifty to sixty minutes of video and up to four hundred stills. The cost and availability to schools also play an important part in the program's design. ScienceVision uses the popular and affordable Apple IIGS computer, with two floppy-disk drives, and a basic videodisc player. Much of this hardware is already available in schools.

Design Considerations

Factors influencing the design and development of the six discs are (1) prior research into instructional videodisc technology, (2) characteristics of the target audience, (3) capabilities of the medium, (4) the inquiry-based learning philosophy advocated by the project, and (5) the state of technology in the schools. The project receives guidance from a Policy Advisory Board, consisting of leaders in science education, educational psychology, and videodisc development. This board has met annually to review the project and its progress. The development of the prototype was based on extensive research by the ScienceVision staff and guidance from the board.

The use of interactive-videodisc technology in the classroom is a relatively new idea itself, but this is not what makes ScienceVision unique. What makes this program different is its use of an inquiry-based instructional design. Such a design provides a more open-ended approach that encourages students to use and develop important science-process skills. These include such skills as classifying, measuring, inferring, describing time-space relationships, experimenting, interpreting data, and formulating models. Traditional instructional-design techniques do not completely apply to ScienceVision materials. In ScienceVision, lessons are not designed to train students or teach sequential procedures. Instead, they provide students with numerous and varied avenues for interactive exploration.

Developed by experienced teachers, the program was also designed to address the limits of the classroom. The demonstrations and activities chosen for the videodisc included activities that were difficult to do, dangerous, beyond the scope of the average middle-school-science classroom, or too time consuming for the teacher.

The fundamental assumption of ScienceVision is that science education should be multidisciplinary and should provide a general science background for all students. The goals of ScienceVision are two-fold: to provide students with a valid understanding of

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science as a human enterprise and to present science as a search for knowledge based upon interpretation of data. In this context, students will develop many of the skills and concepts necessary for interpreting natural phenomena and have a better understanding of today's high technology.

Content

A basic tenant of the IMS philosophy is that science process and content can be learned simultaneously by having both arise out of investigations and active problem-solving activities. Thus, ScienceVision focuses on the higher process skills (e.g., experimentation, model formulation) with processes such as observing, measuring, and classifying being subsumed in the instruction. Activities related to misconceptions about science and the limitations of science, scientific ethics, history of science, and science-related careers will be presented in each disc.

Extensive research conducted by Houghton Mifflin has ensured that the scope and sequence of ScienceVision are compatible with evolving curriculum frameworks and student-performance standards in all fifty states.

The six discs are divided into three topic areas: life science, earth-space science, and physical science. Each disc integrates concepts from the various sciences, and incorporates concepts stressing science, technology, and society.

Context

Students are drawn into to each program by engaging story lines or themes. Each program is divided into two sites, one for each side of the disc. Surveys were conducted with hundreds of students prior to development determines what their interests and the extent of their familiarity of the material planned for each disc.

The specific topics and subject matter of each science area determined what story lines or themes were used. For example, in the ecology disc, students help solve environmental problems by signing on as agents to a nationwide environmental network. In the astronomy disc, students, as television news interns, research the information needed for writing their news stories. The physics disc uses two different themes: roller coasters and sports. Students learn about aspects of force, motion, acceleration, projectile motion, and other physics concepts in designing a roller coaster and helping student athletes improve their performance.

Other themes for discs presently under development include geologic investigations, summer science camps, and oil refinery operation.

Cognition

ScienceVision lessons and activities focus on the development of process skills (observing, classifying, measuring, inferring, predicting, making operational definitions, describing time-space relationships, formulating hypotheses, interpreting data, formulating models). In addition to developing process skills, ScienceVision's activities are designed and structured to improve problem-solving, decision-making, and critical-thinking skills. Coupled with a student activity book, the videodisc portion provides thought-provoking situations and activities in which students can discuss situations and apply scientific knowledge to solve problems. They are also given numerous opportunities to predict what may occur as a result of their actions and recommendations.

Inquiry-Based Learning

ScienceVision uses an inquiry-based approach to learning. This approach is used for several reasons. Inquiry learning encourages students to investigate, question, analyze, and look for patterns in information presented to them. ScienceVision activities and investigations are generally opened-ended. Guidance is provided both on-line and in the printed materials to help students discover ways to structure their research efforts.

Inquiry-based activities fit extremely well into videodisc formats because they make excellent use of videodisc features. Immediate access is possibly the most attractive feature of videodiscs. Inquiry-based lessons are built upon capabilities for accessing a variety of information sources in any order.

Why Use Level III Interactive Videodisc?

An important aspect of ScienceVision lessons, activities and games is the visual and auditory information on the videodisc and the way students use it. Rather than students having to search through written menus and text, they can access all information (data bases, references, resources, videos) by using computer icons on the screen. Students may go to any or all of the sources in any order.

General inquiry questions guide students in their investigations, but choices of what to use and when are controlled by the user. The student manual provides suggested guidelines for ways to proceed through a site (or side of the videodisc). The abilities to search and compare information and sources facilitate the development of student-inquiry and higher order intellectual skills. The ScienceVision design allows almost complete learner control, as students can choose their own pathways through the program.

The videodisc uses actual footage to illustrate content, both concrete and abstract. Students are able to access segments that simulate real-life experiences and situations. The use of student hosts, middle-school students as characters, and contexts familiar to this age group help motivate and sustain interest throughout the programs. These features, integrated with the capabilities of the Apple IIGS computer, provide students with opportunities to participate in situations in which they can make informed decisions about science and its effect on their lives.

Classroom Structure

Although they can be done individually, lessons are designed to be used by small groups. The use of cooperative learning groups has been found to increase achievement for all students. They facilitate the development of higher-level processing skills, a deeper level of understanding, critical thinking, and long-term retention. Inquiry learning is particularly suitable to cooperative learning situations during which students share ideas, explore various pathways, and make decisions together.

Integrating ScienceVision programs into the classroom should be easy because the topics presented are designed to complement and support the numerous science texts and curricula used nationally. Teachers will be able to use the discs according to their strengths and resources and the interests, abilities, and learning styles of their students. Disc structure also provides teachers with choices about what, when, and how to teach the material. Teachers may choose to use the program as a demonstration or a reference source and with individual students, or cooperative groups. Specific methods for integrating the program into the classroom are offered in the teacher's manual.

Hardware Requirements

Use of the Apple IIGS offers teachers and schools an affordable configuration. Many schools already use the Apple IIGS. In addition to basic Apple IIGS components, the following components are needed: Pioneer LD-V2000 or 4200 videodisc player, Apple II Video Overlay card, small amplifier/speaker, and cables. This entire setup is approximately $2,650. If schools already have the Apple IIGS, the cost for additional components can run as low as $1,100. The choice of equipment and the prices involved put the program within reach of many school districts.

At present, three discs are completed and others will follow every two or three months. All six videodiscs are scheduled to be completed by summer of 1991.

Research with ScienceVision

Field testing of materials has begun, and results will be reported as data are collected and analyzed. Houghton Mifflin and Florida State have identified school districts in several regions of the country to ensure a wide cross-section of students. Initial analysis is focusing on content gains by students as well as their ability to interpret, synthesize, and assimilate the information presented in this inquiry-based format. Attitudes toward science are also being studied.

Of additional research interest in the initial field-testing is the process of incidental learning. Students will encounter numerous sources of information during their investigations. As they make connections and inferences about the information they read and see throughout the programs, they are likely to gain additional knowledge in the subject.

Since the pathways followed and decisions made during investigations differ with individual students or groups, the process of problem solving is another important subject of research. Schemata in the selection of actions and acquisition of problem-solving procedures are also being studied.

Educational Implications of ScienceVision

The concerns of the ScienceVision program—intellectual skills, motivation, cooperative learning, integration of computers into the classroom, incidental learning, and problem solving—provide numerous possibilities for research. As development continues and more discs are available for field-testing, many of these concerns will be investigated.

This medium of level III interactive video provides an enormous opportunities for investigations into learning patterns. Science has long been regarded as a subject that involves hours of memorization of facts and processes. ScienceVision is attempting to use the power of videodisc technology to provide students with meaningful experiences—experiences through which they can develop problem-solving skills and begin to see science as an integral part of their daily lives.

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APPENDIX A

Overview and Status of the Project's Products

Life Sciences Disc 1
Ecovision

Ecovision is a fictional, computer-based network that represents a grassroots approach to environmental problem solving. By acting as both a clearinghouse and a resource, EcoVision focuses on increasing young people's awareness of environmental issues and provides support for scientific investigations. Activities emphasize the application of relevant ecological concepts and are designed to help students learn that people can use this knowledge to affect the environment in a positive way.

EcoVision is based at EcoVision Headquarters, which uses a computer network to communicate with clients and agents. The staff at EcoVision Headquarters is composed of middle school students who help coordinate interaction between clients, agent, and EcoVision Headquarters. The staff works with a computer named Chip that provides clients and agents with the resources they need to investigate environmental issues.

Clients are middle school students who contact EcoVision with concerns about environmental issues in their hometowns. The issues are drawn from real-world examples. EcoVision Headquarters gathers background information by working with clients, interviewing experts, locating data bases that provide relevant information, and identifying research related to the issue. This information is stored within EcoVision Resources, which are accessible through Chip.

EcoVision agents are middle school students that log on to the EcoVision network. Students entering the EcoVision network for the first time are greeted by Michelle, the student host. Michelle gives the students information about EcoVision and assigns them the role of EcoVision Agent. After that, students can then select from one of four EcoVision sites where clients have identified problems or concerns. Using EcoVision files to organize their investigation, agents access EcoVision Resources to answer specific questions that have arisen from the issue they are asked

answer specific questions that have arisen from the issue they are asked to investigate. Agents report their findings back to EcoVision.

These findings are checked and the students are provided with feedback.

After that, the information is summarized before being forwarded back to the client and can be used to resolve the problem in the local community.

Goals

Ecovision has three overall goals:

To develop an understanding that an ecosystem is complex and has unique interrelated components.

To provide an awareness that all ecosystems can be investigated with regard to certain unifying principles.

To provide an understanding that disturbances to one aspect of an ecosystem have a potential impact on other aspects of the ecosystem.

Status

Alpha and field testing is completed. Revisions have been made based upon testing. The program will be delivered on March 30, 1991 to Houghton Mifflin Company.

Physical Science Disc 1
Ergomotion

In ErgoMotion, students apply physics concepts and principles to real life situations. On side one, students explore the laws of motion and gravity using a roller coaster. With the aid of a computer simulation, students play the role of coaster engineer and redesign and test a roller coaster.

On side two, students investigate the physics of collisions and momentum in sports. Activities are centered around four middle school athletes who need help with their performance. Using interactive video, students coach the athletes and improve their performance. In the process, students learn how physics plays an important part in sports. Common to both

sides is the Videopedia which serves as a quick reference for the concepts covered by the disc. Using ErgoMotion, students are guided to make the connection between physics and their daily lives.

Goals

Ergomotion has six overall goals:

To understand energy transformation taking place during the roller coaster ride.

To recognize how friction affects kinetic energy and how hill height affects potential energy.

To recognize the differences between velocity and acceleration. Recognize the relationship between gravity and mass.

To understand energy transformation in sports.

To recognize different types of collisions, both elastic and inelastic.

Status

Alpha and field testing is completed. Revisions have been made based upon testing. The program will be delivered on March 30, 1991 to Houghton Mifflin Company.

Earth Science Disc 1

AstroVision

In AstroVision, students take on the role of junior reporters investigating stories for a television news feature. These stories involve investigations into near-space, including the Earth-moon relationship and satellite technology, and explorations into the vast universe, including what we learn from star light and how our views of the universe have changed throughout history. On side one, students are investigating a proposal to establish a research station on the moon. In the process, they may discover the benefits, pros, and cons of space exploration and research. Through observations of the moon and comparisons to Earth, students are able to determine what features of the moon might make it an appropriate site for a research station; in addition, by evaluating information from experts and visuals, they are able to weigh the costs and

benefits of such a venture. They are able to draw conclusions about technological advancements due to space exploration. Using a computer simulation and through observation and experimentation, students can describe the relationship between orbital speed and distance, and gravitational attraction, and mass and gravitational attraction.

Students will conclude how these relationships might affect space travel and research. Students will also explore vast distances in the universe as well as its structure and nature.

Through observation, comparison, and experimentation, students will also be able to determine the stages and time period involved in the life cycle of stars and to identify specific events as stages in the life cycle of a star. Through these activities, with information from historical experts, such as Hertzsprung and Russell, Edwin Hubble, H.S. Leavitt, and Galileo, students draw conclusions concerning the nature of scientific knowledge and advancements.

Goals

Astrovision has five basic goals:

To provide an understanding of scientific processes and knowledge in astronomy.

To understand the immense sizes and distances of outer space and how objects are studied from a distance.

To develop an awareness of how the knowledge of astronomy affects our culture and our future.

To increase awareness of technology created by space study and development.

To increase awareness of careers in astronomy and space travel.

Status

Alpha and field testing is completed. Revisions have been made based upon testing. The program will be delivered on March 30, 1991 to Houghton Mifflin Company.

Physical Science Disc 2
Chemical Pursuits

In Chemical Pursuits, students explore chemistry by assuming the role of a chemist and solving problems. In the introduction they meet the president of Bull Industries, whose companies are beset with problems students can solve by learning chemistry.

On side one, students investigate the nature of organic chemistry by learning about the oil refining process. They investigate basic carbon chemistry, atomic structure, bonding, cracking, polymerization, phase changes, and distillation. With the aid of a computer simulation and interactive video, students can operate the oil refinery for a profit.

On side two, students will track down the source of water pollution on a river using a series of chemical tests. When they discover the cause of the pollution they are given an opportunity to treat the polluted water. To solve the problems on the disc, students explore water solutions, metal ions, acids, bases, chemical reactions, and chemical analysis. Common to both sides is the Videopedia which serves as a quick reference to the concepts covered by the disc. Students using Chemical Pursuits should gain a better understanding of chemistry and the role chemists play in society.

<u>Goals</u>

Chemical Pursuits has eight basic goals:

To discover some ways chemistry is used outside the classroom.
To understand the basic concepts of the structure of matter.
To vary the physical conditions that cause some matter to react.
To become aware of chemistry's relationship to the other sciences.
To recognize the unique role of carbon in organic chemistry.
To become aware of the unique role of water as a medium in many chemical processes.
To develop a broader understanding of the kinetic theory of matter.
To discover various career paths related to chemistry.

Status

Alpha testing was completed in the Fall of 1990 . Field testing is being conducted February through March 1991. Delivery to Houghton Mifflin Company is scheduled for August 30, 1991.

Life Science Disc 2
Life Skills

Lifeskills Camp sets the context for the study of human biology. Lifeskills is located on a major university campus. The camp has been created so that adolescents can research topics of particular interest to them that pertain to human biology. In particular, Lifeskills is interested in providing students with information that will empower them to optimize their lives.

Campers from all parts of the United States are selected by their peers and teachers because they are thoughtful, articulate, and concerned about issues related to health and well-being. Each camper arrives with a particular area of interest, and pursues research in that area using the resources available on campus. Examples of research areas are: growth and development, heredity, evolution, physical fitness, nutrition, blood properties, immunity, behavior, the senses, public health, substance abuse, and mental health. The resources available on the Lifeskills campus include Experts, Databases, References, a computerized human anatomy and physiology laboratory (the BodyLab), and learning centers (Mini-Activities) that allow campers to focus on specific aspects of a research area. In addition, campers bring information about themselves (their Bios), which can be used to relate questions to their own data.

Campers with related questions are divided into teams and conduct their research together. As they use Lifeskills resources, they form answers to their questions. When campers leave, their mission is to report what they have learned from their research and that of fellow campers back to their peers at home.

The Lifeskills videodiscs has been created to document two teams' experiences at camp. The questions of six campers are focused on, and the resources fundamental to each camper's research efforts are provided.

Students using Lifeskills can thus generate their own Lifeskills experience to find answers to these, or possibly their own, questions.

Goals

The overall goals for this disc are to provide the student with an opportunity:

To construct both an individual and holistic understanding of body systems.

To understand the relationship between observable characteristics of the human body and the functioning of specific body systems.

To become aware of personal health issues through consideration of person history, lifestyle characteristics, and present health status.

To understand how personal choices and actions can affect the body.

To develop an attitude toward personal health that is based a through understanding of the body.

To recognize the potential for optimal health through a wellness approach to living.

To become aware of similarities and differences between individuals in the adolescent population.

To become aware of various careers that are related to health and health care.

To recognize how technologies can have an impact on both a personal and societal level.

Status

Alpha testing was completed in the Fall of 1990 . Field testing is being conducted February through March 1991. Delivery to Houghton Mifflin Company is scheduled for August 30, 1991.

Earth Science Disc 2
TerraVision

This disc covers the major topics of (A) geologic history and its effect on resource formation and resource management and (B) plate tectonics and natural disasters. On side one, students play both geologist and detective

as they try to locate and mine a fictitious natural sedimentary resource--Remarkite. They will interpret data from geologic samples--fossils, sedimentary structures, rocks--to determine the depositional environment and the presence of natural resources. Students may also use the law of superposition and cross-cutting relationships to help them analyze the geologic history of a landform. Once Remarkite is discovered, students will consider environmental concerns and costs as they decide which mining and management techniques to use.

On side two of the disc, students explore the reasons for seismic disasters such as earthquakes, volcanoes, and tsunamis. They may conduct on-line investigations for evidence of continental drift in order to reconstruct Pangaea; simulate the plate movements and landform changes resulting from interactions along plate boundaries, such as subduction zones, rift zones, and parallel faults; and manipulate earthquake depth and size in order to observe the consequences. Students may also discover the factors that influence the amount of destruction caused by an earthquake by manipulating variables in a simulation and then conducting a damage assessment.

Goals

This disc has nine basic goals:

To discover the scientific processes and content of geology.

To increase awareness of the interactions among the geologic processes involved in the evolution of landforms.

To increase their comprehension of the immense time periods involved in geologic change and the evolution of a landscape.

To discover the link between technological advancements and the precision and accuracy of scientific data.

To recognize the tentative nature of science as a body of knowledge.

To discover how the management of the Earth's resources affects our global environment.

To understand how geology, interacting with other branches of science, affects our understanding of the past and future.

To discover the various careers related to geology.

To recognize how the application of the science of geology with the help of the latest technology can aid in the exploration of valuable natural

Status

Alpha testing was completed in the Fall of 1990 . Field testing is being conducted February thur March 1991. Delivery to Houghton Mifflin Company is scheduled for August 30, 1991.

We have three more discs in various stages of planning. IMS is ready to seek funds for their completion.

Life Science Disc 3
Life Skills 2

This disc has the same context and goals as Life Skills 1, described earlier. It is an extension of the first Life Skills discs. We have stopped development of this disc as per the recommendations of the review teameven though this disc could be completed for very little additional moneydue to the parallel development with Life Skills 1.

Physical Science Disc 3

This untitled disc will explore energy. Students will examine the full electromagnetic wave spectrum from microwaves to sound. Activities will include exploring waves in order to put energy to use. General energy topics such as frequency, reflection, refraction and transmission will also be covered. Games and activities will provide students with a method of self evaluation.

Earth Science Disc 3
Water and Weather

This disc, nearing the completion of the planning and research phase, will cover meteorology and hydrology. On side one, students will be asked to predict severe weather warnings based on data gathered from meteorological stations around the U.S.--clouds, air masses, fronts, temperature, and relative and absolute humidity. They will also explore

temperature, and relative and absolute humidity. They will also explore the side effects of terrain on weather, technology (computer and satellite) in predicting weather, and the global meteorological network.

On side two of the disc, students will explore the water cycle, tracing rain water through ground water systems and out into the ocean. They will also explore ocean currents and patterns, tides, and the earth's water budget.